American Recovery and Reinvestment Act (ARRA)

FEMP Technical Assistance

United States Federal Agency
Y-12 National Security Complex
Feasibility of Renewable Energy Options (Solar Power)
FEMP Project No. 132
Oak Ridge, TN

September 23, 2010

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Federal Energy Management Program (FEMP)
Technical Services

Supported by Oak Ridge National Laboratory (ORNL)

Prepared by: Sentech, Inc.
Prepared for: Oak Ridge National Laboratory
1 Bethel Valley Road, Building 7001
Oak Ridge, TN 37831

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Executive Summary

Y-12 National Security Complex (Y-12) has requested that a study be made of the feasibility of using solar energy to power Y-12 facilities and processes, including partnering options with the Solar America Initiative and others. The goal is generation of solar electricity that is cost competitive with conventional forms of electricity. A general assessment and review of solar options have been conducted for the Y-12 complex, including a targeted facility study of the New Hope Center (NHC), a third-party owned public interface facility at the Y-12 site.

If the recommended solar PV array were implemented on the New Hope Center it has been determined that 2.0 job-years would be created. The various solar PV scenarios presented for the Y-12 complex range from 180 to 442 job-years depending on the particular scenario.

Potential Green House Gas (GHG) Reduction - The national average is 1,329.35 pounds of CO2 per megawatt hour of electricity consumed. For the Tennessee Valley region, 1,510.44 pounds of CO2 are produced per megawatt hour of electricity consumed. This report addresses the GHG reductions that would result from the solar PV generation options presented.

The following table summarizes the solar PV opportunities indentified:

Solar Option	Cumulative System Size (kW-DC)	Electrical Generation (kWh/yr)	Cost Savings ($/yr) (@$0.04/kWh)	Approx Cost to implement	$ per watt installed	Simple Payback (yrs)	% of Y-12 electrical usage
New Hope Center	26	39,201	$2,340	$187,500	$7.12	80	0.01%
Y-12 Scenario #1	6,616	8,072,195	$322,887	$40.7M	$6.15	126	2.98%
Y-12 Scenario #2	4,616	5,770,195	$230,807	$24.5M	$5.30	106	2.13%
Y-12 Scenario #3	5,016	5,953,795	$238,151	$32.7M	$6.52	137	2.20%
Y-12 Scenario #4	3,016	3,651,795	$146,071	$16.5M	$5.48	112	1.35%

It is not known whether Recovery Act funds can be applied to implement the recommendations derived from this assessment.

The following table is an overview of FY 2009 energy usage for the sites involved:

Site	Energy Source	Avg Annual Usage	Rate Structure	Avg Annual Cost
Y-12 (entire complex)	Electricity	270,500,000 kWh	$0.04/kWh	~$10.8M
	Natural Gas	315,000 MBtu	9.5156/MBtu	~$2.9M
New Hope Center	Electricity	4,500,000 kWh	$0.06/kWh	~$0.270M
	Natural Gas	0	N/A	$0

Description of ARRA Program

On Feb. 13, 2009, Congress passed the American Recovery and Reinvestment Act (ARRA) of 2009 at the urging of President Obama, who signed it into law four days later. A direct response to the economic crisis, the Recovery Act has three immediate goals:

- Create new jobs and save existing ones
- Spur economic activity and invest in long-term growth
- Foster unprecedented levels of accountability and transparency in government spending.[1]

The Federal Energy Management Program (FEMP) facilitates the Federal Government's implementation of sound, cost-effective energy management and investment practices to enhance the nation's energy security and environmental stewardship. To advance that goal and help accelerate agencies' progress, FEMP works to foster collaboration between its Federal agency customers and the U.S. Department of Energy (DOE) national laboratories.

In 2009 and 2010, FEMP has utilized funding from the American Recovery and Reinvestment Act of 2009 (ARRA) to facilitate Federal agency access to the broad range of capabilities expertise at the National Laboratories. Funds were directed to labs to assist agencies in making their internal management decisions for investments in energy efficiency and deployment of renewables, with particular emphasis on assisting with the mandates of the Energy Independence and Security Act of 2007 (EISA) related to Federal facilities and fleets.

FEMP provided major DOE labs with funding that will allow them to respond quickly to provide technical advice and assistance. FEMP applied a simple vetting and approval system to quickly allocate work to each of the labs in accordance with FEMP-provided funding. All assistance provided by the labs was in accordance with the requirements of Federal Acquisition Regulation (FAR) Subpart 35.017 and the labs' designation as "Federal Funded Research and Development Center" (FFRDC) facilities.

In response to the request by FEMP to the Federal agencies Y-12 had requested that a study be made of the feasibility of using solar energy to power Y-12 facilities and processes. The primary focus of the study has been the New Hope Center (NHC) which serves as Y-12's public interface facility.

[1] http://www.recovery.gov/

General Background

Solar power can be used to supplement the electricity the complex uses for day-to-day operations by using photovoltaic solar arrays. New solar technologies have been developed, and are being developed, that are cost-competitive with conventional forms of electricity production (such as coal burning power plants). It is often difficult for industry to balance being fiscally conservative and environmentally conservative. In the near future, solar power may be the answer to achieving this difficult task. While western states have worked with their utilities to form power purchase agreements (PPA), the low cost of electricity in east Tennessee has limited the economic feasibility of solar options. This study will evaluate whether there are economic incentives that would make solar deployment at Y-12 a viable alternative. Specific solar options for the New Hope Center facility are presented as well as general assessment of options for solar deployment across the Y-12 Complex.

Y-12 National Security Complex

Site Description:

Y-12 Complex

The Y-12 complex occupies 811 acres, spanning 2.5 miles, with some 500 buildings that house some 7 million square feet of laboratory, machining, dismantlement, and research and development areas. The complex is situated on general flat terrain which resides between two ridges on its north and south perimeter, essentially creating a valley-like formation.

New Hope Center

The New Hope Center serves as Y-12's public interface facility, located at the east end of the Y-12 complex, outside of the secured perimeter on a 5 acres site. The site area is flat.

Climate: Due to its location in a valley between the Cumberland Mountains to the northwest and the Great Smoky Mountains to the southeast, the weather is tempered relative to areas at the same latitude by slowing and weakening cold winter air from the north and tempering hot summer winds from the west and south. Precipitation is usually in the form of rain, and falls primarily during the winter and in late spring; though sudden thunderstorms are also quite

common in summertime. Snowfall averages approximately 12 inches annually, most often in amounts of less than four inches at one time; it rarely stays on the ground for more than a week.

The average minimum temperature in Oak Ridge, TN in January is 30.5, and the average minimum temperature in July is 67.1. Average precipitation in January is 2.96 inches, and 5.60 inches in July.

Facility Type:

Y-12 Complex

The Y-12 complex is comprised of approximately 500 buildings, multiple large open spaces ranging from 1 to 8 acres, several foundation pads from previously removed structures, and various parking areas.

Y-12 Complex

New Hope Center

The New Hope Center at the Y-12 National Security Complex is a 137,157-sq.-ft. commercial office building that includes a theater-style meeting room with seating capacity of 400. It is a one-story building with a two-story section, and sits on a 5-acre site. The meeting room holds approximately 25 desks and 400 seats, and the building has a total capacity of 1,500 people. The center has been recognized as one of only five LEED Certified facilities in Oak Ridge, and eight in the entire State of Tennessee.

New Hope Center

Operations Description

Y-12 Complex

Operations at the Y-12 facilities include:

- production/rework of complex nuclear weapon components and secondaries;
- receipt, storage, and protection of special nuclear materials;
- quality evaluation/enhanced surveillance of the nation's nuclear weapon stockpile;
- dismantlement of weapon secondaries and disposition of weapon components;
- prevention of the spread of weapons of mass destruction; and
- support to DOE, other federal agencies, and other national priorities.

New Hope Visitors Center

The New Hope Center at the Y-12 National Security Complex is Y-12's public interface facility. It is primarily used for office and meeting space, as well as hosting special events.

Energy Use Accounting

Energy use for the Y-12 complex and New Hope Center are outlined in the following table:

Site	Energy Source	Avg Annual Usage	Rate Structure	Avg Annual Cost
Y-12 (entire complex)	Electricity	270,500,000 kWh	$0.04/kWh	~$10.8M
	Natural Gas	315,000 MBtu	9.5156/MBtu	~$2.9M
New Hope Center	Electricity	4,500,000 kWh	$0.06/kWh	~$0.270M
	Natural Gas	0	N/A	$0

Table 1: Energy Use for Y-12 complex and New Hope Center

Energy Options Considered

Option 1: Solar Photovoltaics (PV)

Y-12 National Security Complex (Y-12) had requested that a study be made of the feasibility of using solar energy to power Y-12 facilities and processes. The primary target of the study has been the New Hope Center (NHC) which is a third-party owned facility at the Y-12 site. In addition, solar deployment options for the overall Y-12 complex have been analyzed and are presented within the findings of this assessment.

New Hope Center

A solar assessment was performed on the New Hope Center with Efficient Energy of Tennessee (EETN), a local solar PV installer, to determine the feasibility of a PV installation. The assessment included: shading analysis, potential system size, installation type, estimated system energy generation and cost.

Figure 1: New Hope Center roof

Site Analysis Findings

The solar site assessment of the New Hope Center indicates that the facility roof is best suited for a PV installation. The facility's roof surfaces present opportunity for near ideal southern orientation of the PV array. Shading analysis indicated favorable conditions with no major obstructions during the primary operating hours of 9AM to 4PM.

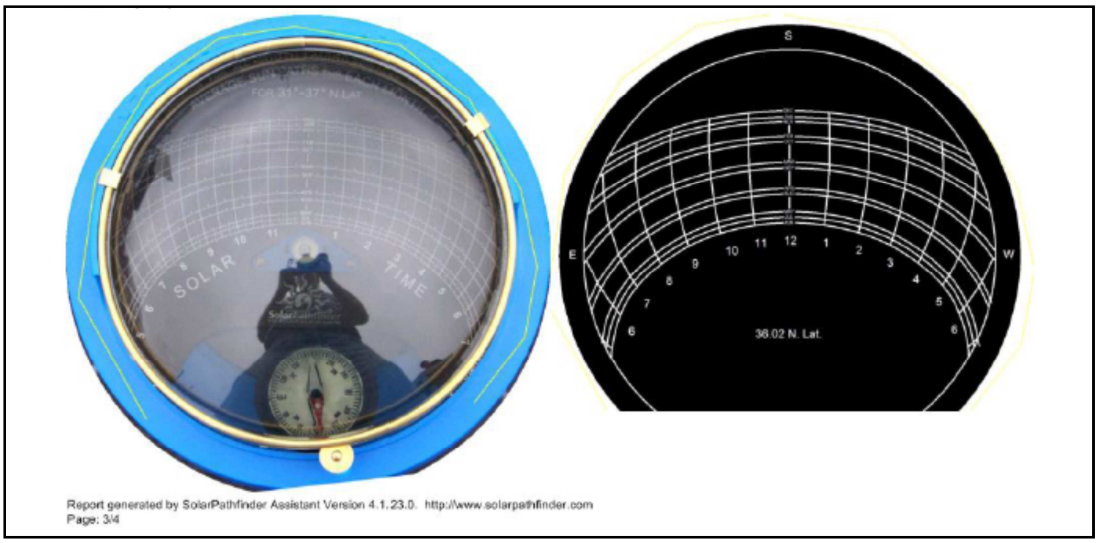


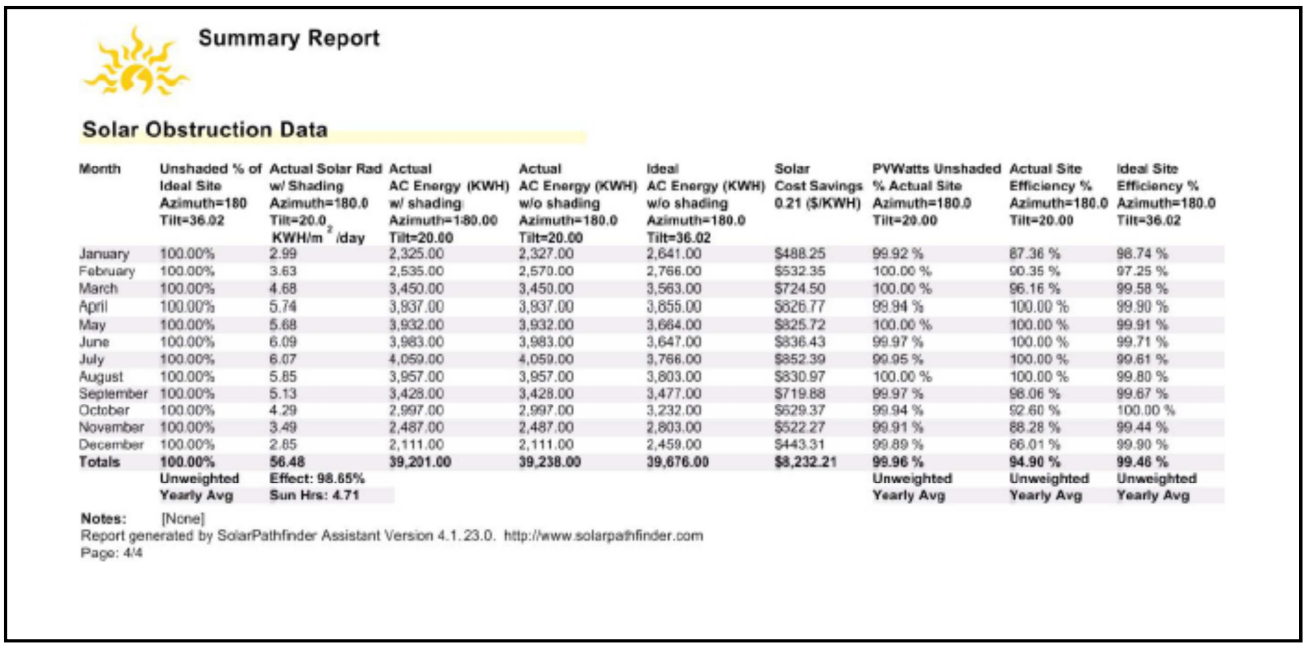
Figure 2: Solar Pathfinder – New Hope Center roof

System Description

The solar assessment indicates that a system size of 26kW could be deployed on the roof surface(s) of the facility. The system would be comprised of (112) solar panels rated at 235W each, mounted on a non-penetrating ballast type racking system in conjunction with a 30kW grid tied inverter.

Annual Energy Generation and Cost Savings

Generation:
The 26kW PV array would generate an estimated 39kWh AC on an annual basis, assuming an installation azimuth of 180 degrees (true south) and a 20 degree array tilt. Figure 3 illustrates the estimated monthly performance of the PV system based on typical solar resources for the local region.



Summary Report

Solar Obstruction Data

Month	Unshaded % of Ideal Site Azimuth=180 Tilt=36.02	Actual Solar Rad w/ Shading Azimuth=180.0 Tilt=20.0 KWH/m² /day	Actual AC Energy (KWH) w/ shading Azimuth=180.00 Tilt=20.00	Actual AC Energy (KWH) w/o shading Azimuth=180.0 Tilt=20.00	Ideal AC Energy (KWH) w/o shading Azimuth=180.0 Tilt=36.02	Solar Cost Savings 0.21 ($/KWH)	PVWatts Unshaded % Actual Site Azimuth=180.0 Tilt=20.00	Actual Site Efficiency % Azimuth=180.0 Tilt=20.00	Ideal Site Efficiency % Azimuth=180.0 Tilt=36.02
January	100.00%	2.99	2,325.00	2,327.00	2,641.00	$488.25	99.92 %	87.36 %	98.74 %
February	100.00%	3.63	2,535.00	2,570.00	2,766.00	$532.35	100.00 %	90.35 %	97.25 %
March	100.00%	4.68	3,450.00	3,450.00	3,563.00	$724.50	100.00 %	96.16 %	99.58 %
April	100.00%	5.74	3,837.00	3,837.00	3,855.00	$626.77	99.94 %	100.00 %	99.90 %
May	100.00%	5.68	3,932.00	3,932.00	3,664.00	$825.72	100.00 %	100.00 %	99.91 %
June	100.00%	6.09	3,983.00	3,983.00	3,647.00	$836.43	99.97 %	100.00 %	99.71 %
July	100.00%	6.07	4,059.00	4,059.00	3,766.00	$852.39	99.95 %	100.00 %	99.61 %
August	100.00%	5.85	3,957.00	3,957.00	3,803.00	$830.97	100.00 %	100.00 %	99.80 %
September	100.00%	5.13	3,428.00	3,428.00	3,477.00	$719.88	99.97 %	98.06 %	99.67 %
October	100.00%	4.29	2,997.00	2,997.00	3,232.00	$629.37	99.94 %	92.60 %	100.00 %
November	100.00%	3.49	2,487.00	2,487.00	2,803.00	$522.27	99.91 %	88.28 %	99.44 %
December	100.00%	2.85	2,111.00	2,111.00	2,459.00	$443.31	99.89 %	86.01 %	99.90 %
Totals	**100.00%**	**56.48**	**39,201.00**	**39,238.00**	**39,676.00**	**$8,232.21**	**99.96 %**	**94.90 %**	**99.46 %**
	Unweighted Yearly Avg	**Effect: 98.65% Sun Hrs: 4.71**					**Unweighted Yearly Avg**	**Unweighted Yearly Avg**	**Unweighted Yearly Avg**

Notes: [None]

Report generated by SolarPathfinder Assistant Version 4.1.23.0. http://www.solarpathfinder.com

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Figure 3

Cost Savings:

Based on the current New Hope Center commercial electric utility rate of $0.06/kWh, the specified PV system would save approximately $2,340/yr. Assuming a 5% annual increase in electric utility rates and a 30 year system operating life, the specified system would yield a total savings of $155,466 for the 30 year operating period.

Cost Analysis

Capital Cost:

The PV system as specified above was quoted by Efficient Energy of Tennessee (EETN) at a total installed cost of $187,500. This installed cost translates to $7.12/watt which is higher than the national average of $6/watt for commercial sized installations, but considered typical for the local region given the current maturity of the Tennessee/Southeast solar market.

Maintenance Cost:

Maintenance related to solar PV systems is generally considered very minimal. The primary maintenance activity associated with PV systems is cleaning of the solar panels. In areas that receive regular rain fall, a cleaning of the panels may be required only annually or perhaps bi-annually to remove dust build-up. PV panels and inverters are routinely warranted for 15-20 yrs with options for purchasing extended warranties. It is possible that an inverter may require replacement during the typical 30 year life span of a PV system. Presently, the cost of an inverter and its subsequent installation cost would account for 7-10% of the total cost of a typical commercial PV installation.

Simple Payback:
The simple payback assuming a fixed utility rate of $0.06/kWh is 80 years. For comparison, the simple payback with the addition of an assumed 5% annual increase to utility rates would yield a 33 year payback.

Financial Incentives:
Initial consideration was given to the New Hope Center for installation of solar PV due to its third party ownership and the potential for the facilities ownership to access Federal, State and Utility incentive programs. In the course of the assessment it was determined that ownership of the building is through a non-profit organizational structure (Oak Ridge Project, LLC). As a result of this ownership structure, eligibility for financial incentives is affected. A list of solar incentives and eligibility of the New Hope Center site is detailed in Table 2 below.

Incentive Source	Incentive Type & Amount	New Hope Center Eligibility
Federal: Investment Tax Credit (ITC)	Tax credit: 30% of total installed cost	Ineligible due to non-profit status
Federal: USDA Grant	Grant: 25% of total installed cost	Ineligible due to non-profit status
State: TN Solar Installation Grants	Grant: $2/watt for systems under 30kW	Possible eligibility depending on on-profit classification
Utility: TVA Generation Partners Program	Grant: $1000 Production credit: $0.12/kWh credit for all PV electrical output, 10 yr contract term	Eligible, but only to utility service account holder

Table 2: Solar Incentives and New Hope Center Eligibility

Utility Incentive Details: The Tennessee Valley Authority (TVA) operates a solar incentive program under the name "TVA Generation Partners Program". Under this program any utility customer can apply for participation in the program. The program is currently limited to PV systems under 200kW, but open to all entities including residential, commercial, non-profit as well as federal entities. Unlike a net-metering system (which TVA does not support), the Generation Partners Program operates a "dual-meter system" which provides a credit to the account holder's bill in the amount of $0.12/kWh for all electrical generation from the PV array. In exchange the utility retains the Renewable Energy Credits (REC's) for the PV based electrical generation. The current contract length from TVA for the program is 10 years. The contract can only be established with the entity that holds the service account with TVA.

Job Creation
Implementation of the described 26kW PV system would generate 2.0 jobs-years[2]

[2] Number of job-years created = Total capital cost ($)/$92,000

Y-12 Complex

A solar evaluation of the Y-12 complex was performed by Outpost Solar, a local area solar PV installer, the results of which have been reviewed and analyzed in the course of this assessment. The evaluation attempted to identify the maximum solar PV resources available to the Y-12 complex through the use of multiple PV technologies and installation techniques. The following assessment serves as a high level summary of solar potential for the Y-12 sites with approximations of cost, electrical generation, savings and payback.

Site Analysis Findings

A total of 21 potential sites for various PV installations were identified as shown in Figure 4. It should be noted that several of the listed sites (mainly demolished building pads) have been converted to employee parking areas, and that the landfills require special approvals for use.

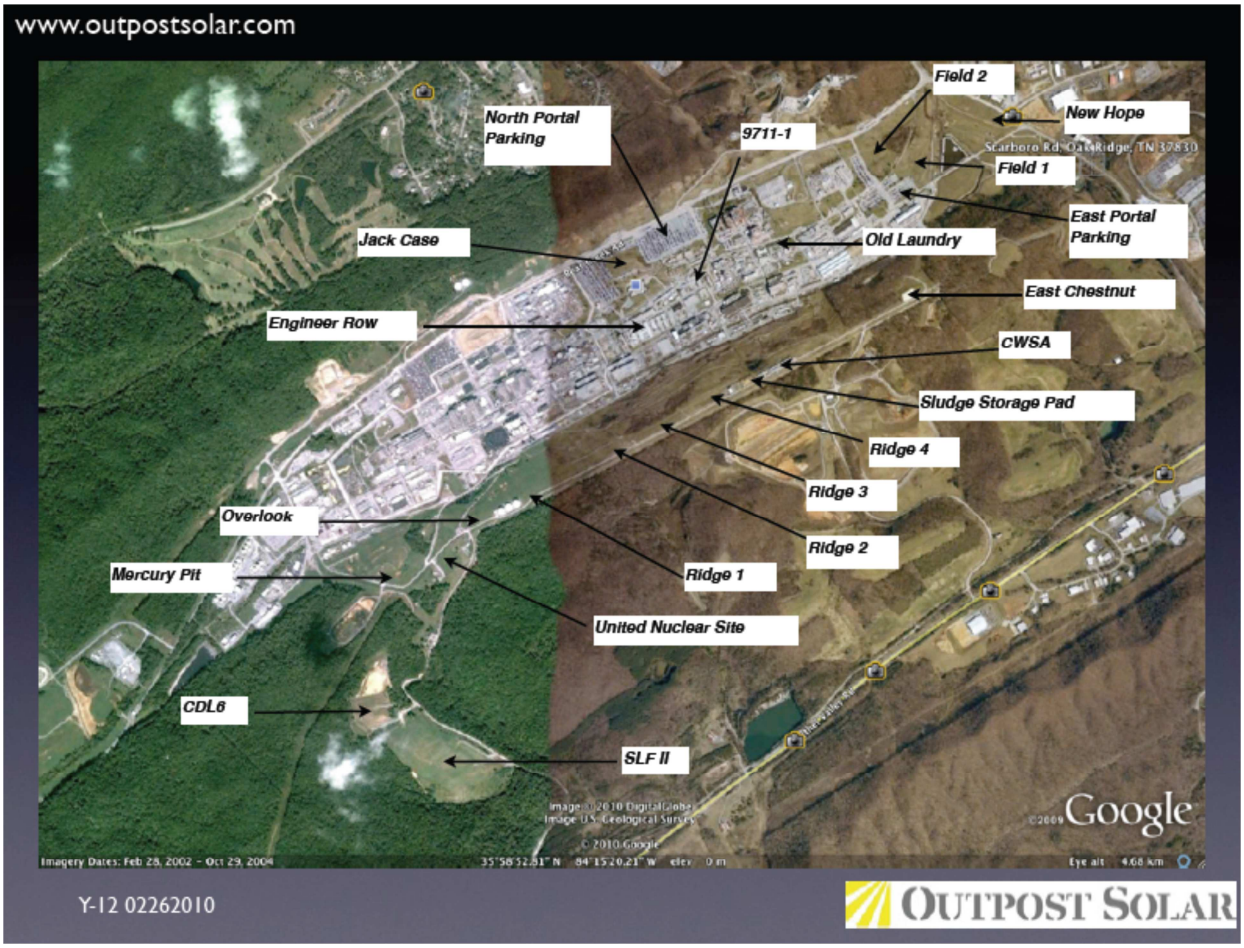


Figure 4

System Description

Three primary installation systems were considered as part of this evaluation:

- Parking Area Solar Arrays (PASA), see figure 5
- Scalable Ground Mount (SGM), see figure 6
- Photovoltaic Ground Cover System (PGS), see figure 7

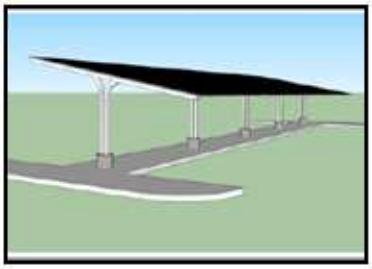


Figure 5 - PASA

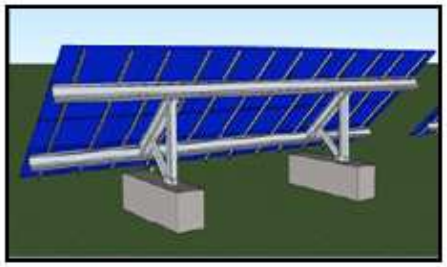


Figure 6 - GSM

Figure 7 - PGS

A set of 4 installation scenarios were developed based on impact to total cost using sites identified in Figure 4 in combination with the installation systems identified in Figures 5, 6 and 7. The four scenarios can be described as follows:

- Scenario #1: All sites identified in figure 4
- Scenario #2: All sites identified in figure 4, except the North Portal Parking (NPP) site
- Scenario #3: All sites identified in figure 4, except the Sanitary Landfill II (SLF II) site
- Scenario #4: All sites identified in figure 4, except the NPP and SLF II sites

A detailed description of the installation scenarios can be found in Appendix B.

Annual Energy Generation and Cost Savings

Generation: See Table 3 below
Cost Savings: See Table 3 below

Cost Analysis

Capital Cost: See Table 3 below
Maintenance Cost: Maintenance costs are the same as outlined earlier for the New Hope Center assessment
Simple Payback: See Table 3 below

Solar Option	Cumulative System Size (kW-DC)	Electrical Generation (kWh/yr)	Cost Savings ($/yr) ($0.04/kWh)	Approx Cost to implement	$ per watt installed	Simple Payback (yrs)	% of Y-12 electrical usage

Y-12 Scenario #1	6,616	8,072,195	$322,887	$40.7M	$6.15	126	2.98%
Y-12 Scenario #2	4,616	5,770,195	$230,807	$24.5M	$5.30	106	2.13%
Y-12 Scenario #3	5,016	5,953,795	$238,151	$32.7M	$6.52	137	2.20%
Y-12 Scenario #4	3,016	3,651,795	$146,071	$16.5M	$5.48	112	1.35%

Table 3: Y-12 Complex Solar Options Summary

Financial Incentives:
As a Federal facility, Y-12 is not eligible for the majority of the solar incentives present for the region. Table 4 summarizes Y-12's eligibility for solar incentives.

Incentive Source	Incentive Type & Amount	Y-12 Eligibility
Federal: Investment Tax Credit (ITC)	Tax credit: 30% of total installed cost	**Ineligible** as a Federal entity
Federal: USDA Grant	Grant: 25% of total installed cost	**Ineligible** as a Federal entity
State: TN Solar Installation Grants	Grant: $2/watt for systems under 30kW	**Ineligible** as a Federal entity
Utility: TVA Generation Partners Program	Grant: $1000 Production credit: $0.12/kWh credit for all PV electrical output, 10 yr contract term	Eligible, but program currently has a system size limit of 200kW-DC

Table 4: Solar Incentives and Y-12 Eligibility

Job Creation
Implementation of PV systems as described in Scenarios #1-4 would have the following job creation values:

- Y-12 Scenario #1: 442 job-years[3]
- Y-12 Scenario #2: 266 job-years[4]
- Y-12 Scenario #3: 356 job-years[5]
- Y-12 Scenario #4: 180 job-years[6]

Additional Considerations

[3-6] Number of job-years created = Total capital cost ($)/$92,000

Mechanical Tracking: Use of mechanical tracking could be considered in some ground mount applications as a means of increasing electrical production output from a given PV array. Industry figures indicate productivity improvements of between 15% and 35% depending on the type of tracking system deployed and level of solar resources available. Installed costs typically run in the range of $0.40 to $0.80 per watt of PV installed. Some general guidelines when considering tracking:

- Single axis tracking units are generally preferred in commercial and utility scale installations due to the inherent robustness of their supporting structure. The simplicity of the mechanisms also results in high reliability which keeps maintenance costs low.
- Generally it is more economically feasible to consider tracking on systems greater than 200kW in size due to costs associated with installation.

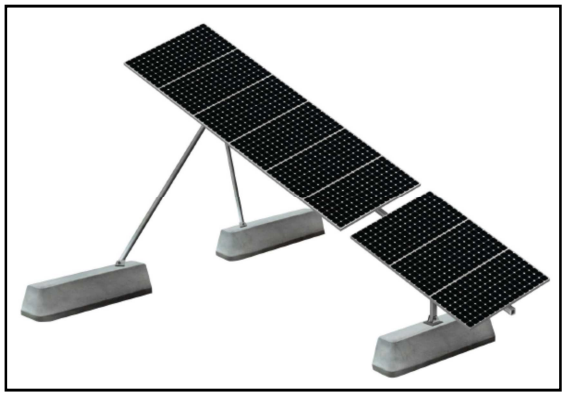


Figure 8 – Tilted Single Axis Tracker

Figure 9 – Horizontal Single Axis Tracker

Conclusions of Solar Assessment

New Hope Center

Under the present ownership structure of the New Hope Center an installation of a solar PV system does not appear feasible. The lack of access to financial incentives resulting from Oak Ridge Project LLC's non-profit status and inability to participate in the TVA Generation Partners Program leaves no viable means for the ownership to recover the cost of the capital investment. (Note: Oak Ridge Project LLC is not eligible for TVA program because the utility service account is currently under Lawler Wood LLC, the facility management company for the New Hope Center. The TVA program only allows payment to the service account holder.).

Y-12 Complex

Given Y-12's inability to access most financial solar incentives combined with the current installed cost of solar PV technology, it does not appear economically feasible to pursue solar PV installations when taking into consideration the extremely low cost of electricity currently contracted with TVA ($0.04/kWh). Table 5 illustrates the correlation of installed cost per watt vs. simple payback for Y-12 Scenario #1. As costs of solar PV technology continue to decline and as electricity rates potentially rise, a further review of the economic feasibility of solar PV installations at Y-12 may be warranted in the next few years.

Assumed future installation cost	Estimated timeframe of	Y-12 Scenario #1 System Size	Installed Cost	Cost Savings ($/yr)	Simple Payback

	market cost structure*	(KW)		($0.04/kWh)	(yrs)
$5/watt	2011-2012	6,616	$30.83M	$322,887	95 yrs
$4/watt	2012-2015	6,616	$26.46M	$322,887	82 yrs
$3/watt	2015-2020	6,616	$19.84M	$322,887	61 yrs
$2/watt	2020-2030	6,616	$13.23M	$322,887	41 yrs
$1/watt	TBD	6,616	$6.61M	$322,887	20 yrs

*Assumes commercial scale installations: typically less than 1MW

Table 5: Installed cost per watt vs. simple payback assuming $0.04/kWh electricity rates

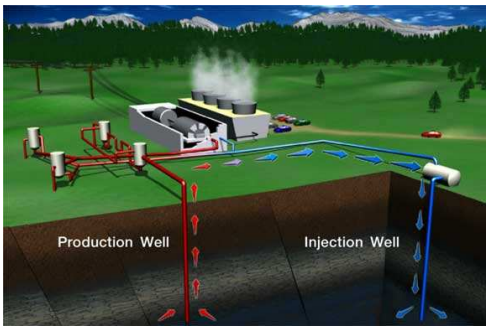
Other Renewable Options Considered

Option 2: Wind (Small/Vertical Turbine)

Small wind turbines are small enough that they can be suitable for use on properties encompassing as little as one acre of land in most areas of the country, unlike utility-scale turbines. A 5 kW turbine with an 18 ft diameter would provide enough power to meet the demand of a typical American home. The average height of a small wind turbine (of any capacity) is approximately 80 ft. The average payback period depends on many factors, and as such, can range anywhere from 6 to 30 years based on a price of $30,000.

Assessment: It has been determined that wind power is not feasible at Y-12 because average wind speed for the area is typically less than 3 mph which is considered a minimum requirement for economical system performance.

Option 3: Geothermal

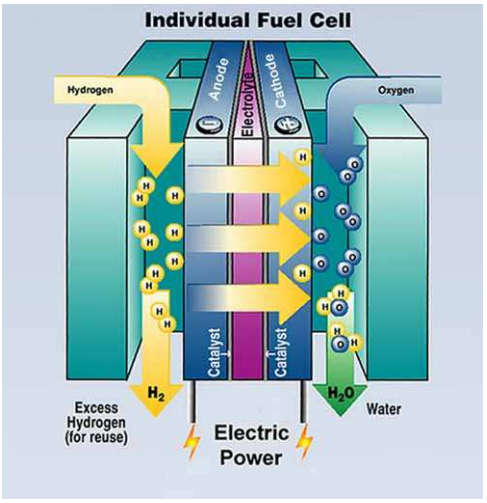


There are three methods by which geothermal heat can be used to generate electricity: dry steam, flash steam and binary cycle. Due to their relative abundance, moderate-temperature sites running binary-cycle power plants are the most common type of geothermal electricity producers. Since geothermal power does not rely on variable sources of energy like wind or solar, the average capacity factor is generally much higher (in 2005 the global average was 73%).

Assessment: When considering the Y-12 site specifically, the use of geothermal heat to supply steam for electricity generation is not a considered a feasible option due to risks associated with present ground source contamination issues as a result of Y-12's operating history with radioactive materials.

Option 4: Fuel Cell

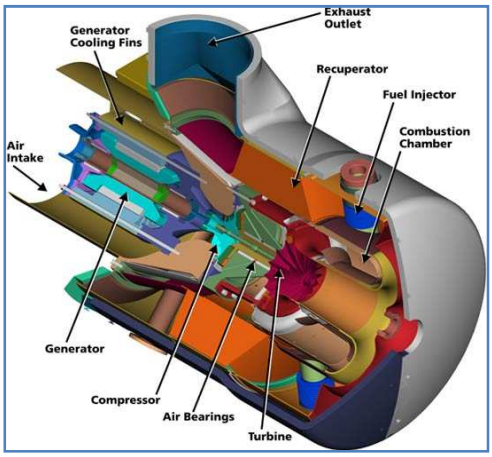
A **fuel cell** is an electrochemical cell that converts a source fuel into an electric current. It generates electricity inside a cell through reactions between a fuel and an oxidant, triggered in the presence of an electrolyte. The reactants flow into the cell, and the reaction products flow out of it, while the electrolyte remains within it. Fuel cells can operate continuously as long as the necessary reactant and oxidant flows are maintained. A hydrogen fuel cell uses hydrogen as its fuel and oxygen (usually from air) as its oxidant



Assessment: During the course of the study, it was determined that a source of excess hydrogen exists from a current on-site manufacturing process. The excess hydrogen is currently being vented into the atmosphere. Utilizing this excess hydrogen in a fuel cell application is a potential area for future study.

ECM 5: Biogas/MicroTurbine

Microturbines are compact turbine generators that deliver electricity onsite, or close to the point where it is needed. They are designed to operate on a variety of gaseous and liquid fuels including: low or high pressure natural gas, biogas (landfill, wastewater treatment centers, anaerobic), flare gas, diesel, propane and kerosene. Microturbines feature maintenance-free air bearings, the lowest emissions of any non-catalyzed fossil fuel combustion, and digital power conversion.



Assessment: At this point this technology is not yet considered to be fully commercially viable and an immediate source of biogas (example landfill methane) is not readily available, however the technology potential warrants further review in the near future.

Potential Green House Gas Reductions

The following table summarizes GHG reductions for the solar options presented.

GHG reductions based on eGrid Subregion Emissions SERC Tennessee Valley			
		Carbon dioxide (CO2)	
Solar Option	Electricity Output/Offset (MWh)	Output Emission Rate (lb/MWh)	**GHG Reduction (tons)**
New Hope Center	39	1,510.44	**29.45**
Y-12 Scenario 1	8,072	1,510.44	**6,096.13**
Y-12 Scenario 2	5,770	1,510.44	**4,357.61**
Y-12 Scenario 3	5,954	1,510.44	**4,496.57**
Y-12 Scenario 4	3,652	1,510.44	**2,758.06**

Action Plan for Implementation of Energy Options

Solar options presented under "Y-12 Scenarios 1-4" are technically feasible and could be executed by regional or national PV installers. If the presented cost estimates can be justified in order to comply with Federal mandates, then a detailed RFP should be issued for a national bid given the size and scope of potential installations.

Option #4 (Fuel cell) requires further study to determine if the hydrogen source from the on-site process is sufficient enough to support a fuel cell installation.

Funding Assistance Available

Y-12 would have access to the TVA Generation Partners Program as outlined previously in Option 1. The TVA program provides a $0.12/kWh generation credit for systems up to 200kW in size and for a contract period of 10 years. In exchange, TVA retains all REC's associated with the PV generation. The program cap of 200kW would therefore have a limited financial impact on a large MW scale deployment of solar PV.

Alternate Financing: ESPC and UESC are not applicable in the consideration of solar deployment at Y-12. A EUL would most likely not be economically viable for the 3rd party given currently grid interconnection restrictions associated with the TVA Generation Partners incentive program and 3rd party arrangements.

Contact information

Oak Ridge National Labs Technical Contact:
Oak Ridge National Labs
Building 3156, M/S 6067
Oak Ridge, TN 37830
Attn: John Rast
Phone: 865-241-8163
Email: rastjl@ornl.gov

Y-12 National Security Complex Energy Manager Contact:
Y-12 National Security Complex
P.O. Box 2009, MS-8068
Oak Ridge, TN 37831
Attn: Rosanne Smith
Phone: 865-576-0615
E-mail: rox@y12.doe.gov

Technical Contact and Report Drafting:
Sentech Inc.
835 Innovation Dr, Suite 100
Knoxville, TN 37932
Attn: Bob Slattery
E-mail: Bslattery@sentech.org

Solar Resources and Estimates Courtesy of:

Outpost Solar, LLC
1905 Mines Road, Suite 200
Pulaski, TN 38478
Attn: Wilson Stevenson
Phone: 800-416-8374 or 206-416-8374
E-mail: Wilson.stevenson@outpostsolar.com

Efficient Energy of Tennessee (EETN)
1707 Depot Street
Powell, TN 37849
Attn: Harvey Aboulata
Phone: 865-386-7860
E-mail: Harvey@eetenn.com

Appendix A

New Hope Center Financial Analysis with all available incentives:

Solar PV system ROI / Payback considering Grants, Incentives and Rebates							
Solar System Size (kilowatts)		26.32			35,684	kWh	Estimated Annual Power Production †
Installed Cost	$	187,500			$ 7.12		Installed Cost per KW
Average retail rate per kWh	$	0.0950					
TVA Generation Partners rate (kWh)	$	0.1200					
TVA GPP total Buy Back Rate		0.215					
Annual Income (ten year contract)	$	7,672	ROI	34%			Based on an initial investment of $22438
Annual Income after contract	$	3,390	ROI	15%			Based on an initial investment of $22438

Grant	%	Grant Cap	Grant Amount	Running Cost	ROI	Links for more information
TN-CET Grant	40%	$ 75,000	$ 75,000	$ 112,500	6.8%	Tennessee Clean Energy Technology Grant
USDA Grant	25%	$ 500,000	$ 46,875	$ 65,625	11.7%	USDA Rural Development Renewable Energy Grant
TVA start up Grant		$ 1,000	$ 1,000	$ 64,625	11.9%	TVA Generation Partners Program
Federal Tax Credit	30%	None	$ 42,188	$ 22,438	34.2%	Business Energy Investment Tax Credit (ITC)
Federal Tax depreciation basis		$ 119,531				
Tax Bracket assumption	34%					
Depreciation Tax Value			40,641	$ (18,203)		GetSolar.com for detailed tax information
Tax Expense (year 1)			$ (28,449)	$ 10,245		
Interest Expense over financing			$ -	$ 10,245		
Interest Tax Effect over financing			$ -	$ 10,245		
†† Final Cost of System				$ 10,245	74.9%	

* Efficient Energy of Tennessee does not control, make any claims, guarantees and or if a grant is awarded.
For more information on Grants please visit: http://www.dsireusa.org/

Rates are based on current pricing information available.
*** Efficient Energy of Tennessee does not control, make any claims, guarantees regarding increases or decreases in utility rates.

†† Efficient Energy of Tennessee does not make any representation, claim or offer any type of tax advice.
The calculations are examples only. Consult your accountant for tax advice and estimated ROI.

† Efficient Energy of Tennessee does not guarantee power production beyond the manufacturer warranty.
Estimates are based on equipment outlined, no shade and
Sun / hours are based on historical averages.

New Hope Center Financial Analysis with all available incentives except USDA:

Solar PV system ROI / Payback considering Grants, Incentives and Rebates							
Solar System Size (kilowatts)		26.32			35,684	kWh	Estimated Annual Power Production †
Installed Cost	$	187,500			$ 7.12		Installed Cost per KW
Average retail rate per kWh	$	0.0950					
TVA Generation Partners rate (kWh)	$	0.1200					
TVA GPP total Buy Back Rate		0.215					
Annual Income (ten year contract)	$	7,672	ROI	14%			Based on an initial investment of $55250
Annual Income after contract	$	3,390	ROI	6%			Based on an initial investment of $55250

Grant	%	Grant Cap	Grant Amount	Running Cost	ROI	Links for more information
TN-CET Grant	40%	$75,000	$ 75,000	$ 112,500	6.8%	Tennessee Clean Energy Technology Grant
USDA Grant			$ -	$ 112,500	6.8%	USDA Rural Development Renewable Energy Grant
TVA start up Grant		$ 1,000	$ 1,000	$ 111,500	6.9%	TVA Generation Partners Program
Federal Grant	30%	None	$ 56,250	$ 55,250	13.9%	Business Energy Investment Tax Credit (ITC)
Federal Tax depreciation basis		$ 159,375				
Tax Bracket assumption	34%					
Depreciation Tax Value			54,188	$ 1,062		GetSolar.com for detailed tax information
Tax Expense (year 1)			$ (28,449)	$ 29,511		
Interest Expense over financing			$ -	$ 29,511		
Interest Tax Effect over financing			$ -	$ 29,511		
†† Final Cost of System				$ 29,511	26.0%	

* Efficient Energy of Tennessee does not control, make any claims, guarantees and or if a grant is awarded.
For more information on Grants please visit: http://www.dsireusa.org/

Rates are based on current pricing information available.
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† Efficient Energy of Tennessee does not guarantee power production beyond the manufacturer warranty.
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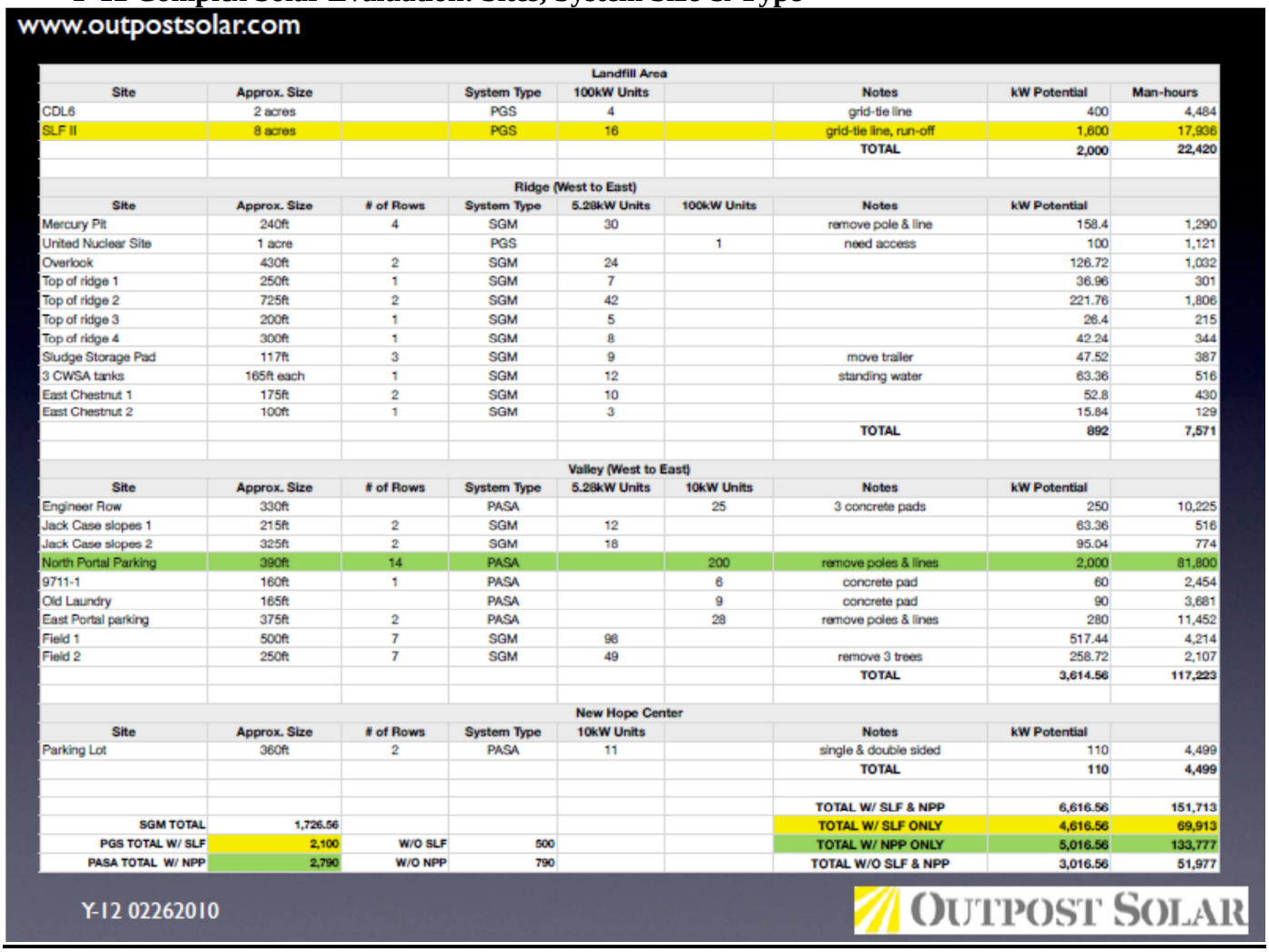
Sun / hours are based on historical averages.

Courtesy of Efficient Energy of Tennessee

Appendix B

Y-12 Complex Solar Evaluation: Sites, System Size & Type



Landfill Area

Site	Approx. Size		System Type	100kW Units		Notes	kW Potential	Man-hours
CDL6	2 acres		PGS	4		grid-tie line	400	4,484
SLF II	8 acres		PGS	16		grid-tie line, run-off	1,600	17,936
						TOTAL	2,000	22,420

Ridge (West to East)

Site	Approx. Size	# of Rows	System Type	5.28kW Units	100kW Units	Notes	kW Potential	
Mercury Pit	240ft	4	SGM	30		remove pole & line	158.4	1,290
United Nuclear Site	1 acre		PGS		1	need access	100	1,121
Overlook	430ft	2	SGM	24			126.72	1,032
Top of ridge 1	250ft	1	SGM	7			36.96	301
Top of ridge 2	725ft	2	SGM	42			221.76	1,806
Top of ridge 3	200ft	1	SGM	5			26.4	215
Top of ridge 4	300ft	1	SGM	8			42.24	344
Sludge Storage Pad	117ft	3	SGM	9		move trailer	47.52	387
3 CWSA tanks	165ft each	1	SGM	12		standing water	63.36	516
East Chestnut 1	175ft	2	SGM	10			52.8	430
East Chestnut 2	100ft	1	SGM	3			15.84	129
						TOTAL	892	7,571

Valley (West to East)

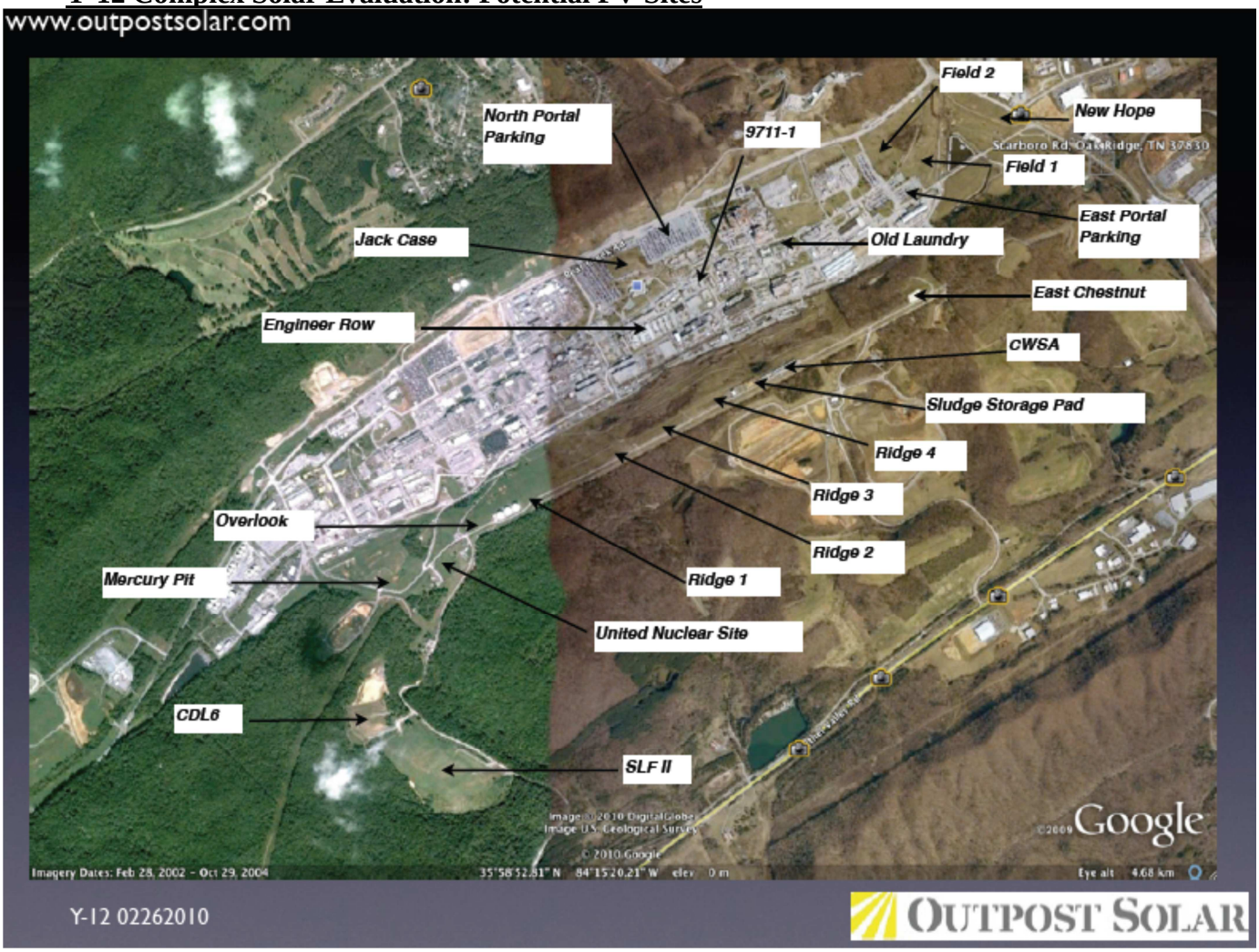
Site	Approx. Size	# of Rows	System Type	5.28kW Units	10kW Units	Notes	kW Potential	
Engineer Row	330ft		PASA		25	3 concrete pads	250	10,225
Jack Case slopes 1	215ft	2	SGM	12			63.36	516
Jack Case slopes 2	325ft	2	SGM	18			95.04	774
North Portal Parking	390ft	14	PASA		200	remove poles & lines	2,000	81,800
9711-1	160ft	1	PASA		6	concrete pad	60	2,454
Old Laundry	165ft		PASA		9	concrete pad	90	3,681
East Portal parking	375ft	2	PASA		28	remove poles & lines	280	11,452
Field 1	500ft	7	SGM	98			517.44	4,214
Field 2	250ft	7	SGM	49		remove 3 trees	258.72	2,107
						TOTAL	3,614.56	117,223

New Hope Center

Site	Approx. Size	# of Rows	System Type	10kW Units		Notes	kW Potential	
Parking Lot	360ft	2	PASA	11		single & double sided	110	4,499
						TOTAL	110	4,499
						TOTAL W/ SLF & NPP	6,616.56	151,713
SGM TOTAL	1,726.56					TOTAL W/ SLF ONLY	4,616.56	69,913
PGS TOTAL W/ SLF	2,100	W/O SLF	500			TOTAL W/ NPP ONLY	5,016.56	133,777
PASA TOTAL W/ NPP	2,790	W/O NPP	790			TOTAL W/O SLF & NPP	3,016.56	51,977

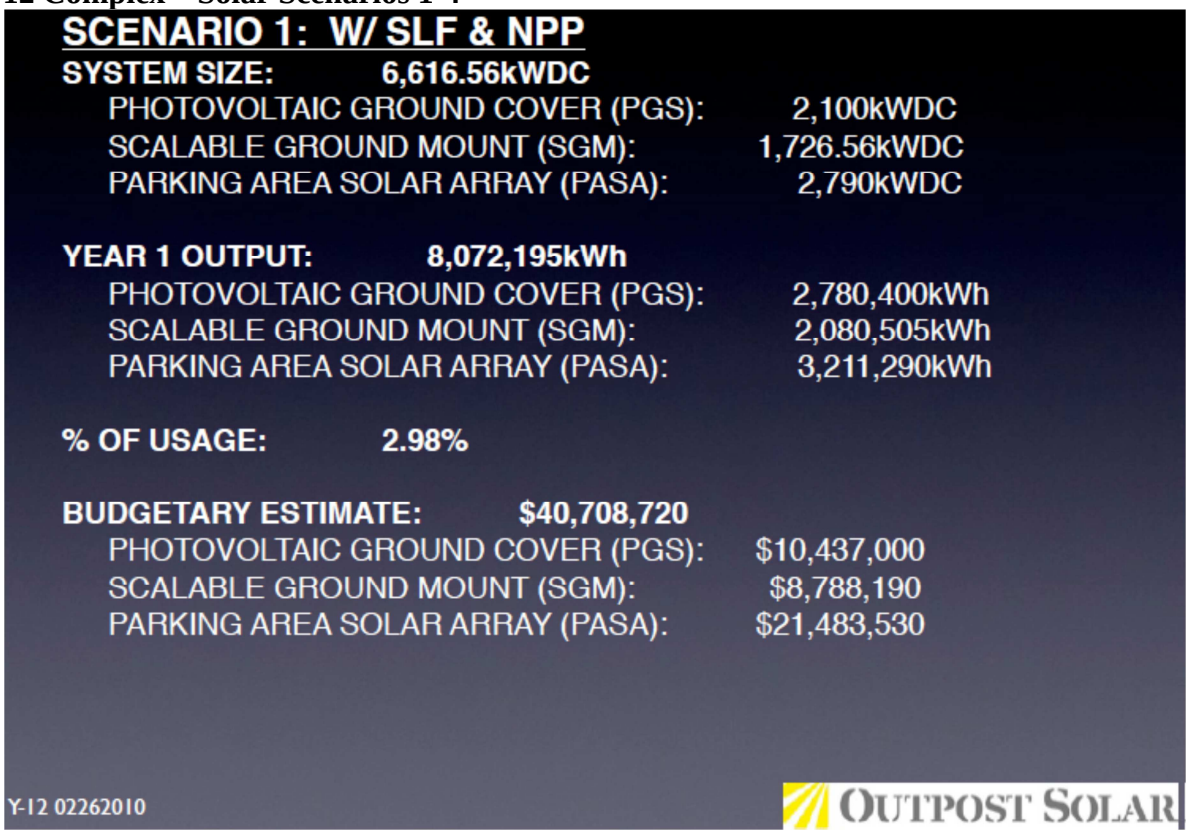
Courtesy of Outpost Solar

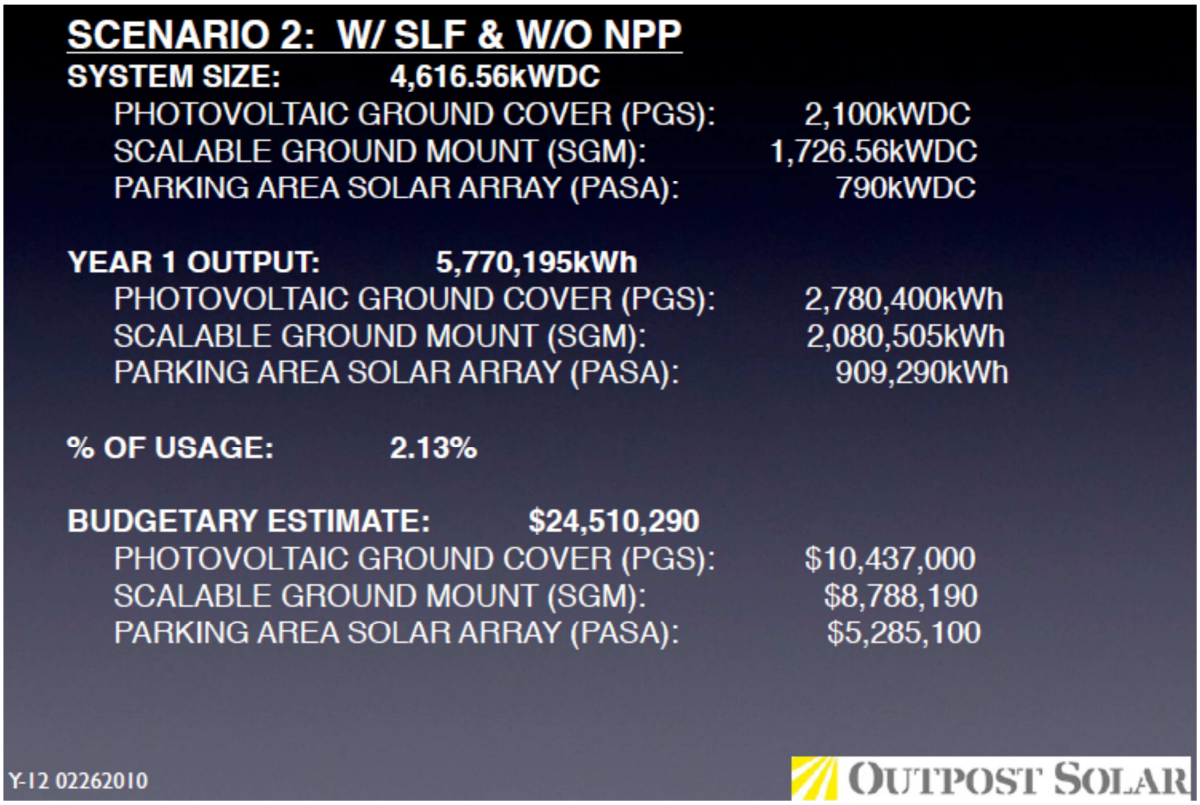
Y-12 Complex Solar Evaluation: Potential PV Sites



Courtesy of Outpost Solar

Y-12 Complex – Solar Scenarios 1-4





SCENARIO 3: W/ NPP & W/O SLF

SYSTEM SIZE: 5,016.56kWDC

PHOTOVOLTAIC GROUND COVER (PGS):	500kWDC
SCALABLE GROUND MOUNT (SGM):	1,726.56kWDC
PARKING AREA SOLAR ARRAY (PASA):	2,790kWDC

YEAR 1 OUTPUT: 5,953,795kWh

PHOTOVOLTAIC GROUND COVER (PGS):	662,000kWh
SCALABLE GROUND MOUNT (SGM):	2,080,505kWh
PARKING AREA SOLAR ARRAY (PASA):	3,211,290kWh

% OF USAGE: 2.20%

BUDGETARY ESTIMATE: $32,756,720

PHOTOVOLTAIC GROUND COVER (PGS):	$2,485,000
SCALABLE GROUND MOUNT (SGM):	$8,788,190
PARKING AREA SOLAR ARRAY (PASA):	$21,483,530

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OUTPOST SOLAR

SCENARIO 4: W/O SLF & W/O NPP

SYSTEM SIZE: 3,016.56kWDC

PHOTOVOLTAIC GROUND COVER (PGS):	500kWDC
SCALABLE GROUND MOUNT (SGM):	1,726.56kWDC
PARKING AREA SOLAR ARRAY (PASA):	790kWDC

YEAR 1 OUTPUT: 3,651,795kWh

PHOTOVOLTAIC GROUND COVER (PGS):	662,000kWh
SCALABLE GROUND MOUNT (SGM):	2,080,505kWh
PARKING AREA SOLAR ARRAY (PASA):	909,290kWh

% OF USAGE: 1.35%

BUDGETARY ESTIMATE: $16,558,290

PHOTOVOLTAIC GROUND COVER (PGS):	$2,485,000
SCALABLE GROUND MOUNT (SGM):	$8,788,190
PARKING AREA SOLAR ARRAY (PASA):	$5,285,100

Y-12 02262010

OUTPOST SOLAR